2.0 UPPER RIO GRANDE (PART 1) BACKGROUND

For practical purposes, the Upper Rio Grande watershed was divided into two investigations (i.e., Parts 1 and 2). The Upper Rio Grande (Part 1) was intensively sampled by the New Mexico Environment Department/Surface Water Quality Bureau (NMED/SWQB) from May to October, 2000 and is addressed in this document. Surface water quality monitoring stations were selected to characterize water quality of the stream reaches (Table 2.1, Figure 2.1). Most of all the perennial tributaries to the Rio Grande in New Mexico (NM) can be found within the Upper Rio Grande. The Red River subwatershed was excluded from the 2000 investigation, as that portion of the Upper Rio Grande was surveyed in a separate intensive study during 1999.

2.1 Location Description and History

The Upper Rio Grande (Part 1) watershed (US Geological Survey [USGS] Hydrologic Unit Codes [HUCs] 13020101 and 13010005) is located in north central NM. The entire Upper Rio Grande watershed encompasses approximately 7,500 square miles (mi^2) and extends over portions of seven counties including Rio Arriba, Taos, Santa Fe, Los Alamos, Sandoval, Mora, and San Miguel. The Upper Rio Grande (Part 1) includes the main stem of the Rio Grande between Pilar, NM, and the NM-Colorado (CO) border, as well as tributaries that enter the Rio Grande in that reach.

Several land grants were established along the Upper Rio Grande and its tributaries because water for domestic and irrigation purposes was necessary to the early settlers. The establishment of land grants also protected Upper Rio Grande towns and Spanish missions from attack by nomadic tribes (Westphall 1983). Because the archives of NM were destroyed during the Pueblo Revolt, little information is available regarding land grants prior to 1680 (Ebright 1994). The first recorded (lasting) land grant in the Taos Valley following the reconquest by Diego de Vargas in 1692 was to Captain Cristobal de la Serna (1715) for land in the Ranchos de Taos-Talpa area (Martinez 1968). Many of the Northern Pueblo lands became occupied by Spanish settlers following the reconquest by de Vargas. Spanish settlers moved to Taos Pueblo for safety from the Comanche Indians and other Plains tribes (Westphall 1983). Sixty-three families settled and built the Taos Plaza in 1797-98 under the Don Fernando de Taos Grant (Martinez 1968), and Taos became the center of the fur trade in the 17th century (Westphall 1983). Other Taos Valley grants included the Quijosa Grant (1715), Martinez or Godoi Grant (1716), Antoine Leroux Grant I (1742), Las Trampas Grant (1751), Rancho del Rio Grande Grant (1795), Don Fernando de Taos and Santa Barbara Grants (1796), and Arroyo Hondo Grant (1815). Nearly one-third of the 1.5-million acres of Taos county was contained in gifts or grants from either Spain or Mexico (Martinez 1968).

In an 1815 lawsuit, the Taos Pueblo petitioned the local alcalde (mayor) asking him to measure the land to which the Pueblo was entitled (Ebright 1994). Taos Pueblo and Picuris Pueblo were eventually recognized by the Mexican government and formally identified by surveys confirmed by the United States government in 1858 (Carlson 1975). During the last half of the 1800s, Spanish-Americans acquired much of the irrigable cropland within the eight Northern Pueblo

Indian Grants of the Upper Rio Grande Valley and received titles following hearings by the Pueblo Lands Board (Carlson 1975). Today, much of the Taos Valley is still used for agriculture (Figure 2.1).

The geology of the Upper Rio Grande watershed consists of a complex distribution of Precambrian metamorphic rocks, Paleozoic sedimentary rocks and Tertiary volcanics (Table 2.2, Figure 2.2). Smaller deposits of intrusives, ash flows and unaltered igneous rocks are also present. The Upper Rio Grande river bisects the two distinct geologic areas. The area west of the Rio Grande mainly consists of late Quaternary to Tertiary basalts formed as a result of the Rio Grande Rift tectonic events. The Tertiary volcanics (mainly basalt flows) are interbedded with sands and gravels, which were deposited during periods of erosion between volcanic events. The Rio Grande River has incised a deep canyon through these basalt flows, which extends from the CO border to Velarde. Immediately east of the Rio Grande recent alluvial deposits cover these basalt deposits. The source of this alluvial material is the Sangre de Cristo Mountains, which parallel the river in a north-south direction. The Sangre de Cristo mountains mainly consist of Precambrian metamorphic rocks (amphibolites, granite, gneiss, and mica schist) and granitic stocks. Dikes of rhyolite, monzonite porphyry, latite and andesite are also common. Not as common, but still notable, are the scattered deposits of Pennsylvanian sediments including conglomerates, sandstones, shales and limestones. This portion of the Sangre de Cristo range is highly mineralized and heavily mined, as a result.

Table 2.1 SWQB/NMED 2000 Upper Rio Grande (Part 1) Sampling Stations

Station	Latitude, decimal degrees	Longitude, decimal degrees	Elevation, feet	Station Location
1	36.981944	-106.074166	8,044	Los Pinos at USGS gage
2	36.962200	-106.156100	8,155	Los Pinos above NMDGF area at FS bridge
3	36.993611	-106.038333	8,036	Rio San Antionio at NM-CO border in Ortiz
4	36.857777	-106.129444	8,809	Rio San Antonio at FR 87 bridge
5	36.942222	-105.454444	8,150	Ute Creek above Costilla Creek at Hwy 196 in Amalia
6	36.831944	-105.318611	8,960	Costilla Creek below Comanche Creek
7	37.001111	-105.722222	7,485	Rio Grande at NM-CO border at USGS gage in CO
8	36.534444	-105.709444	6,545	Rio Grande below Rio Pueblo de Taos at USGS gage
9	36.000000	-105.415100	6,616	Rio Grande below Red River at Lama
10	36.418138	-105.342713	8,917	Rio Fernando de Taos at Hwy 64 bridge
11	36.779167	-105.275278	9,220	Comanche below upper exclosure
12	36.834166	-105.343611	8,900	Costilla Creek at Costilla-Vermejo boundary
13	36.897417	-105.260583	9,400	Casias Creek above Costilla Reservoir
14	36.338918	-105.729667	6,099	Rio Pueblo de Taos at Rio Grande
15	36.380380	-105.663770	6,665	Rio Pueblo de Taos 20m below Taos effluent channel
16	36.377222	-105.668611	6,670	Rio Pueblo de Taos 20m above Taos effluent channel
17	36.298939	-105.581830	7,270	Rio Grande del Rancho at USGS gage
18	36.276111	-105.576388	7,400	Rito de la Olla at bridge on Hwy 518
19	36.260706	-105.575417	7,498	Rio Grande del Rancho at Hwy 518 bridge
20	36.332200	-105.578600	7,223	Rio Chiquito at USGS gage
21	36.387777	-105.631388	6,730	Rio Grande del Rancho below Rio Chiquito
22	36.390000	-105.630555	6,730	Rio Pueblo de Taos near Los Cordovas
23	36.394875	-105.605471	6,818	Rio Fernando de Taos near Lower Ranchito
24	36.421000	-105.579700	8,051	Rio Lucero above Rio Pueblo de Taos
24a	36.508300	-105.530200	8,051	Rio Lucero at USGS gage on Taos Pueblo
25	36.375555	-105.549166	7,175	Rio Fernando de Taos at USGS gage
26	36.352500	-105.395100	7,162	San Cristobal Creek
27	36.398611	-105.609920	6,792	Rio Pueblo de Taos near Lower Ranchito
28	36.535833	-105.708333	7,000	Rio Hondo at Rio Grande confluence
29	36.534166	-105.710000	6,550	Rio Grande below Rio Hondo
30	36.541666	-105.556388	7,700	Rio Hondo 1.5 miles above Valdez
31	36.596000	-105.449000	9,899	North Fork Rio Hondo at Taos Ski Valley Parking Lot
32	36.831944	-105.318611	8,960	Comanche Creek at mouth on Rio Costilla
33	36.596388	-105.453611	9,343	Rio Hondo 50 feet above WWTP
34	36.847222	-105.380000	8,746	Latir Creek at Costilla Creek
35	36.864900	-105.449900	9,467	Cordova Creek 300 m upstream from Day Lodge
36	36.900278	-105.432500	8,588	Cordova Creek above Costilla Creek above Hwy 196
37	36.922777	-105.446944	8,180	Sanchez Creek above Costilla Creek
38	36.919166	-105.446388	8,190	Costilla Creek above Amalia at Hwy 196 culvert bridge
39	36.966666	-105.507500	7,950	Costilla Creek above Costilla at Hwy 196 bridge
40	36.831944	-105.318611	8,960	Costilla Creek above Comanche

Table 2.2 Geologic Unit Definitions for the Upper Rio Grande (Part 1)

Geologic Unit Code	Definition
IP	Pennsylvanian (age) rocks
J	Jurassic rocks, Middle and Upper, undivided
J_{sr}	San Rafael Group; consists of Entrada Sandstone, Todilto and Summerville Formations
K	Cretaceous rocks, undivided
K_d	Dakota Sandstone; includes Oak Canyon, Cubero, and Paguate Tongues plus Clay Mesa Tongue of Mancos Shale
K_{kf}	Kirtland and Fruitland Formations; coal-bearing, coal primarily in the Fruitland; Campanian to Maastrichtian
K_m	Mancos Shale; divided into Upper and Lower parts by Gallup Sandstone
MD	Mississippian and Devonian rocks, undivided; includes the Lake Valley Limestone
MD_pc	Mississippian and Devonian rocks, undivided; includes the Lake Valley Limestone; Precambrian
pC	Precambrian
P_c	Castile Formation; dominantly anhydrite sequence; Upper Permian
P_d	Permian (age), unknown formation
P_g	Glorieta Sandstone; texturally and mineralogically mature, high-silica quartz sandstone
PIP	Combination of Permian and Pennsylvanian (age) rock units
Q_{ab}	Alluvium; upper and middle Quaternary; Basalt and andesite flows and locally vent deposits
Q_{al}	Alluvium; upper and middle Quaternary
Q_b	Quaternary Basalt and andesite flows and locally vent deposits
QT_b	Basaltic and andesitic volcanics interbedded with Pleistocene and Pliocene sedimentary units
QT_p	Older piedmont alluvial deposits and shallow basin fill
QT_s	Upper Santa Fe Group
SOC	Silurian through Cambrian rocks, undivided
T_{bb}	Tertiary Basalt
T_{ca}	Carson conglomerate
TK	Combination of Tertiary and Cretaceous (age) rock units
TK_i	Paleogene and Upper Cretaceous intrusive rocks
T_p	Tertiary pediment deposit
T_{pi}	Tertiary (age) pyroclastic and intrusive rocks (volcanic rocks of varying compositions)
TR	Triassic rocks, general
T_{sa}	Tertiary (age), unknown formation
T_v	Middle Tertiary volcanic rocks, undifferentiated

Figure 2.1 SWQB/NMED 2000 Upper Rio Grande (Part 1) Sampling Stations

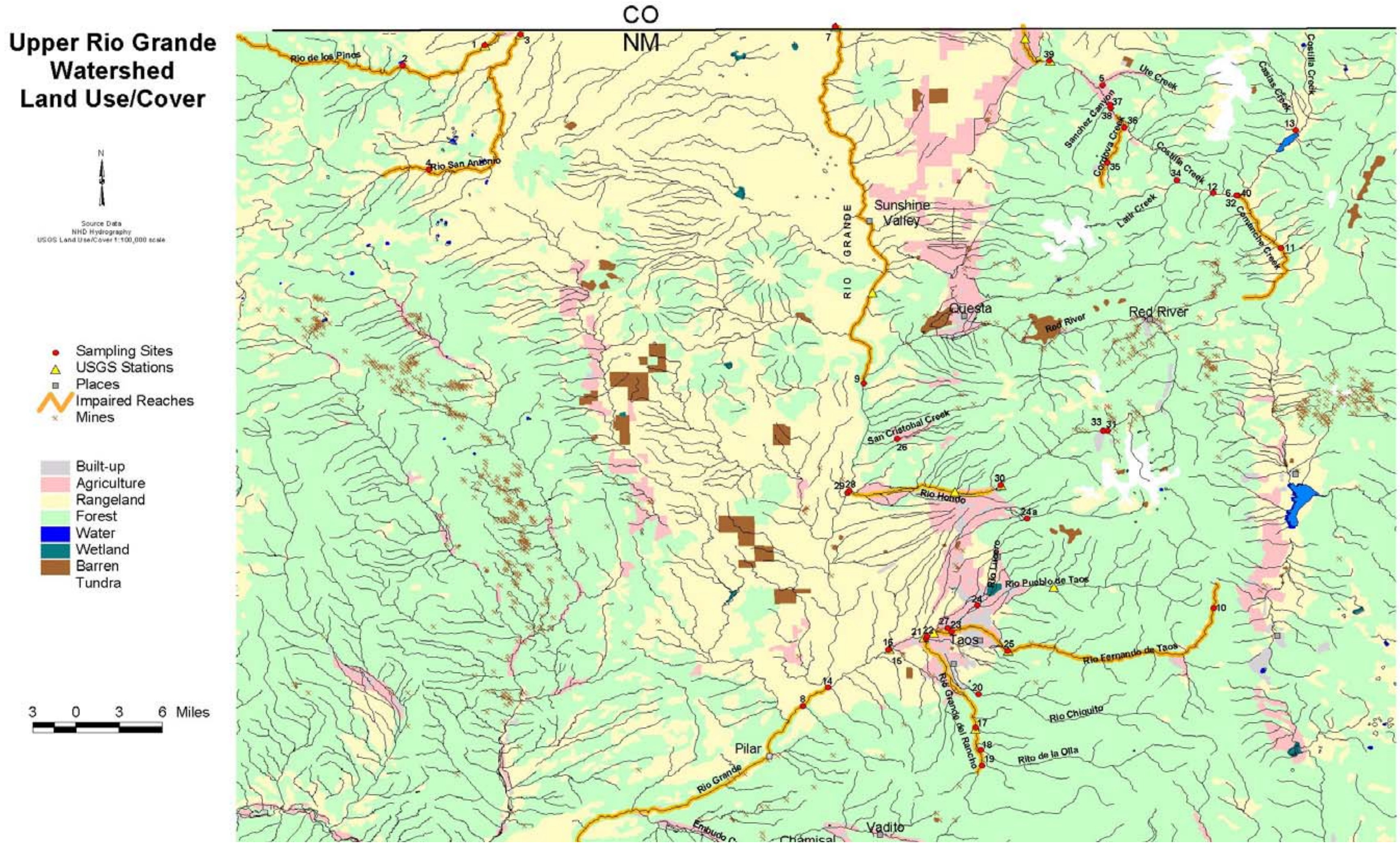
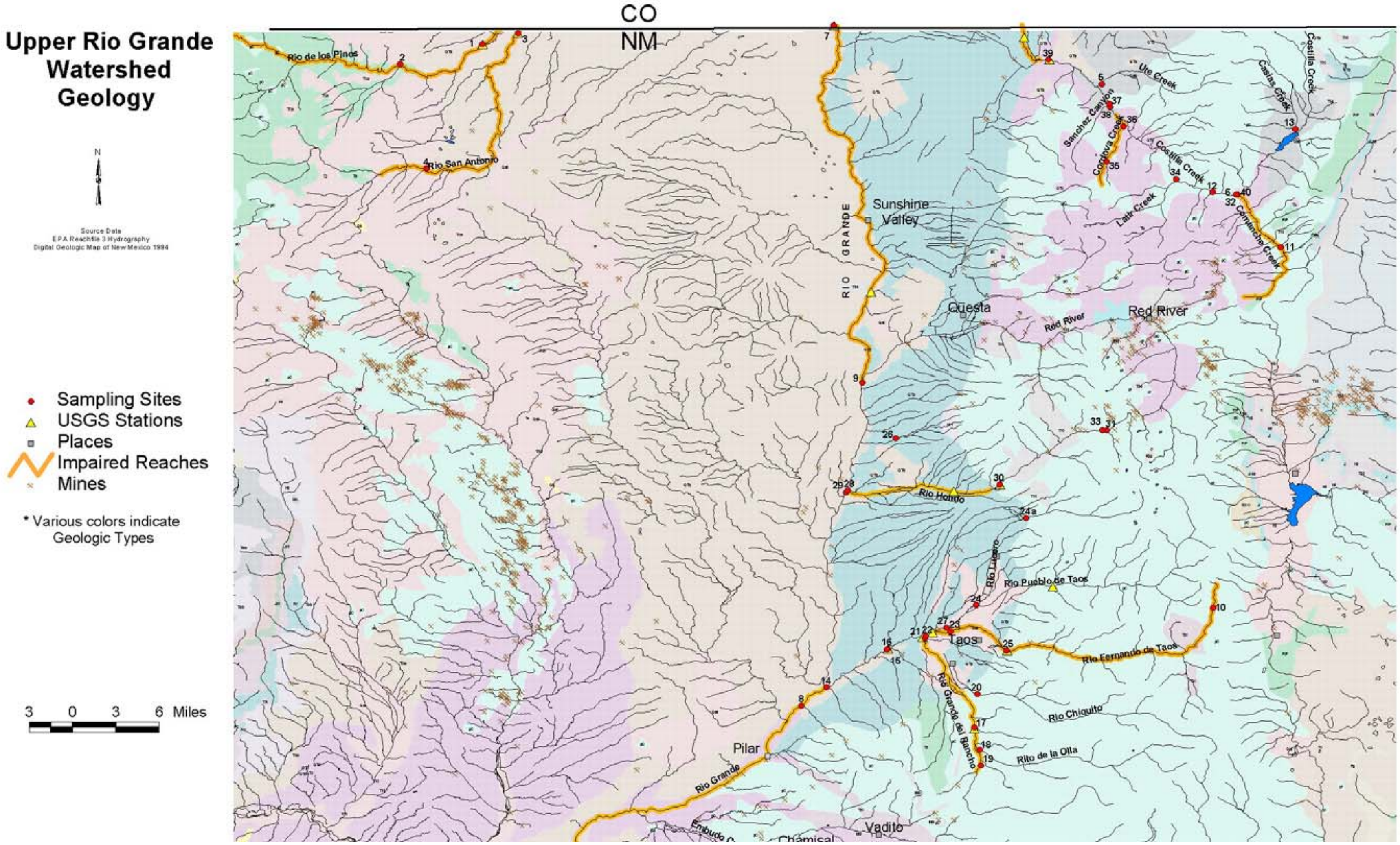


Figure 2.2 Upper Rio Grande (Part 1) Geology



2.2 Water Quality Standards

Water quality standards (WQS) for all assessment units in this document are set forth in sections 20.6.4.12, 20.6.4.122, 20.6.4.123, and 20.6.4.900 of the 2002 NM Standards for Interstate and Intrastate Surface Waters (NM Administrative Code [NMAC] 20.6.4). NMAC 20.6.4.122 reads as follows:

> **RIO GRANDE BASIN**-The main stem of the Rio Grande from Taos Junction bridge upstream to the NM-CO line, the Red river from its mouth on the Rio Grande upstream to the mout of Placer creek, and the Rio Pueblo de Taos from its mouth on the Rio Grande upstream to the mouth of the Rio Grande del Rancho.
>
> **A. Designated Uses**: coldwater fishery, fish culture, irrigation, livestock watering, wildlife habitat, and primary contact.
>
> **B. Standards**:
>
> (1) In any single sample: pH shall be within the range of 6.6 to 8.8, temperature shall not exceed 20 degrees Celcius (^{o}C) (68 degrees Farenheit [^{o}F]), and turbidity shall not exceed 50 Nephelometric Turbidity Units (NTU). The use-specific numeric standards set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.
>
> (2) The monthly geometric mean of fecal coliform bacteria shall not exceed 100/100 milliliters (mL); no single sample shall exceed 200/100 mL (see Subsection B of 20.6.4.13 NMAC).

NMAC 20.6.4.123 reads as follows:

> **RIO GRANDE BASIN**-The Red river upstream of the mouth of Placer creek, all tributaries to the Red river, and all other perennial reaches of tributaries to the Rio Grande in Taos and Rio Arriba counties unless included in other segments.
>
> **A. Designated Uses**: domestic water supply, fish culture, high quality coldwater fishery, irrigation, livestock watering, wildlife habitat, and secondary contact.
>
> **B. Standards**:
>
> (1) In any single sample: conductivity[2] shall not exceed 400 micromhos (µmhos) (500 µmhos for the Rio Fernando de Taos), pH shall be within the range of 6.6 to 8.8, temperature shall not exceed 20^{o}C (68^{o}F), and turbidity shall not exceed 25 NTU. The use-specific numeric standards set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.
>
> (2) The monthly geometric mean of fecal coliform bacteria shall not exceed 100/100 mL; no single sample shall exceed 200/100 mL (see Subsection B of 20.6.4.13 NMAC).

[2] The current water quality standards erroneously refer to "conductivity" when the intention was "specific conductance." Specific conductance means conductivity adjusted to 25 degrees C. SWQB proposed changing all references from conductivity to specific conductance at the recent (February 2004) trienniel review hearing. This proposal is expected to be accepted by the WQCC and EPA. Therefore, the term specific conductance is used throughout this TMDL document.

NMAC 20.6.4.900 provides standards applicable to attainable or designated uses unless otherwise specified in 20.6.4.101 through 20.6.4.899. NMAC 20.6.4.12 lists general standards that apply to all surface waters of the state at all times, unless a specified standard is provided elsewhere in NMAC.

2.3 Intensive Water Quality Sampling

The Upper Rio Grande (Part 1) watershed was intensively sampled by the SWQB/NMED in 2000. A brief summary of the survey and the hydrologic conditions during the sampling events is provided in the following subsections.

2.3.1 Survey Design

Water quality samples were collected during three seasons (spring, summer, and fall) in 2000. Temperature data were collected in 2000 and again in 2002 because some data collected during the 2000 survey were lost. Follow-up monitoring for temperature was completed in July to September, 2003. Surface water quality monitoring stations were selected to characterize water quality of the stream reaches. Table 2.1 and Figure 2.1 present the SWQB water quality monitoring station locations sampled in 2000. Figure 2.3 shows thermograph locations from the follow-up monitoring for temperature in 2003. Stations were located to evaluate the impact of tributary streams and to determine ambient water quality conditions. The results of the survey were summarized in a water quality survey report (SWQB/NMED 2000a).

All temperature, chemical/physical, and stream bottom deposits (SBD) sampling and assessment techniques are detailed in the *Quality Assurance Project Plan* (QAPP, SWQB/NMED 2000b). As a result of the 2000 monitoring effort and subsequent assessment of results, several exceedences of NM WQS for several streams were documented. Accordingly, these impairments were added to NM’s 2002-2004 CWA §303 (d) list (SWQB/NMED 2002).

2.3.2 Hydrologic Conditions

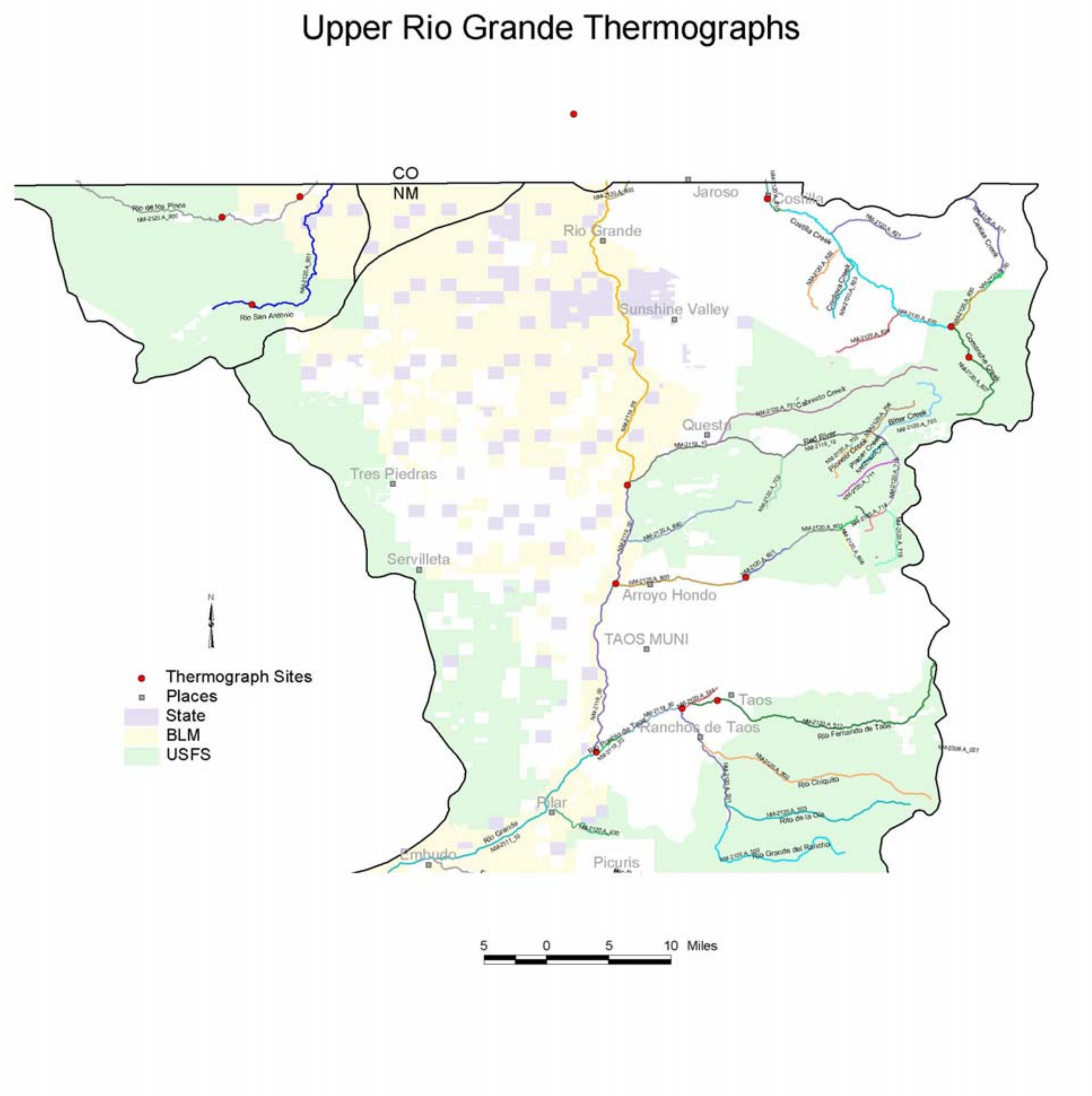
Stream discharge, measured by SWQB/NMED staff in spring, summer, and/or fall at thirteen stations, is summarized in Table 2.3.

Table 2.3 Stream Discharge Measured or Estimated by SWQB/NMED (2000), Upper Rio Grande (Part 1)

Station	May 16-17 Discharge (cfs)	July 16-17 Discharge (cfs)	Jul 31–Aug 1 Discharge (cfs)
4 (Rio San Antonio)	11.3[(a)]	2.5[(a)]	0[(b)]
5 (Ute Creek above Costilla Creek @ Hwy 196 in Amalia)	<1.0[(b)]	0.1[(b)]	<0.25[(b)]
10 (Rio Fernando de Taos)	0.27[(a)]	0.1[(b)]	0.1[(b)]
12 (Costilla Creek @ Costilla-Vermejo boundary)	113	3.84	111.5
14 (Rio Pueblo de Taos)	12.7[(a)]	7.3	4.1[(a)]
17 (Rio Grande del Rancho)	27.3	3.6[(a)]	3.25
19 (Rio Grande del Rancho)	15.1[(a)]	1.9[(a)]	1.3[(a)]
22 (Rio Pueblo de Taos)	3.7[(a)]	2.9	0.98[(a)]
23 (Rio Fernando de Taos)	1.6[(a)]	0.36[(a)]	0.23[(a)]
25 (Rio Fernando de Taos)	3.7[(a)]	0.29[(a)]	0.38[(a)]
26 (San Cristobal Creek)	<1.0[(b)]	0.26[(a)]	0.304[(a)]
27 (Rio Pueblo de Taos)	2.1	1.6[(a)]	1.2[(a)]
28 (Rio Hondo)	7.7	8.6	7.5[(a)]
31 (North Fork Rio Hondo)	4.5[(b)]	2.6[(a)]	1.0[(a)]
32 (Comanche Creek)	5.4[(a)]	1.4[(a)]	1.6[(a)]
33 (Rio Hondo)	18.2	5.0	5.1[(a)]
34 (Latir Creek @ Costilla Creek)	9.45[(a)]	2.08[(a)]	3.38[(a)]
36 (Cordova Creek above Costilla Creek @ Hwy 196)	<1.0[(b)]	<0.1[(b)]	<0.25[(b)]

Notes:
[(a)] Estimated flow (fewer than 20 measurements across the channel)
[(b)] Visual estimation (no measurements)
cfs = Cubic feet per second

Figure 2.3 Upper Rio Grande (Part 1) Thermograph Locations (2003)



There are also 14 USGS gaging stations in the Upper Rio Grande (Part 1) watershed (Table 2.4), nine of which are active. USGS gage locations are presented in Figure 2.1. Minimum, mean, and maximum stream flows for the periods of record at these stations are also provided in Table 2.4. Daily streamflows for active USGS gages are presented graphically in Figures 2.4 through 2.11 for the 2000 calendar year. Gage data are not provided for Rio Grande del Rancho near Talpa, NM because all flows were estimated for the 2000 calendar year.

Streamflows at these gage locations during the spring (May 16 to May 17), summer (July 31 to August 2), and fall (October 17 to October 19) sampling events are as follows:

- Streamflow was 124 cubic feet per second (cfs) on May 16 and 126 cfs on May 17 on Costilla Creek near Costilla, NM (Figure 2.4). During the summer sampling event at this location, streamflows were 87 cfs (July 31), 97 cfs (August 1), and 100 cfs (August 2). During the fall sampling event, streamflows were 9.6 cfs (October 17), 9.3 cfs (October 18), and 8.6 cfs (October 19);

- Streamflow was 27 cfs on May 16 and 22 cfs on May 17 on Costilla Creek near Garcia, CO (Figure 2.5). During the summer sampling event, streamflows were less than 1 cfs (July 31) and zero cfs on August 1 and 2. During the fall sampling event, streamflow was 2.6 cfs (October 17). Data are unavailable for October 18 to 19 at this location;

- Streamflow was 167 cfs on May 16 and 149 cfs on May 17 on Los Pinos River near Ortiz, CO (Figure 2.6). During the summer sampling event, streamflows were 11 cfs, 12 cfs, and 11 cfs on July 31, August 1, and August 2, respectively. During the fall sampling event, streamflows were 16 cfs, 15 cfs, and 16 cfs on October 17 through October 19, respectively;

- Streamflow was 235 cfs on May 16 and 206 cfs on May 17 on Rio Grande near Cerro, NM (Figure 2.7). During the summer sampling event, streamflows were 61 cfs, 59 cfs, and 59 cfs on July 31, August 1, and August 2, respectively. During the fall sampling event, streamflows were 86 cfs, 81 cfs, and 77 cfs on October 17 through October 19, respectively;

- Streamflow was 30 cfs on May 16 and May 17 on Rio Hondo near Valdez, NM (Figure 2.8). During the summer sampling event, streamflows were 10 cfs, 9.8 cfs, and 9.5 cfs on July 31, August 1, and August 2, respectively. During the fall sampling event, streamflows were 12 cfs, 11 cfs, and 11 cfs on October 17 through October 19, respectively;

- Streamflow was 13 cfs on May 16 and May 17 on Rio Pueblo de Taos below Los Cordovas, NM (Figure 2.9). During the summer sampling event, streamflows were 4.4 cfs, 3.9 cfs, and 3.8 cfs on July 31, August 1, and August 2, respectively. During the fall sampling event, streamflows were 9.7 cfs, 9.1 cfs, and 9.9 cfs on October 17 through October 19, respectively;

- Streamflow was 16 cfs on May 16 and May 17 on Rio Pueblo de Taos near Taos, NM (Figure 2.10). During the summer sampling event, streamflows were 5.0 cfs, 4.7 cfs, and 4.6 cfs on July 31, August 1, and August 2, respectively. During the fall sampling event, streamflow was 4.7 cfs on October 17 through October 19;

- Streamflows were 9.7 cfs and 9.1 cfs, respectively, on May 16 and May 17 on San Antonio River at Ortiz, CO (Figure 2.11). During the summer sampling event (July 31, August 1, and August 2), streamflow was zero cfs. During the fall sampling event, streamflows were 1.9 cfs, 2.0 cfs, and 2.2 cfs on October 17 through October 19, respectively.

Table 2.4 USGS Upper Rio Grande (Part 1) Gage Stations

Station	Latitude, decimal degrees	Longitude, decimal degrees	Elevation, feet	Mininum Annual Flow, cfs	Maximum Annual Flow, cfs	Mean Annual Flow[a], cfs	Station Location (Period of Record)
08255500	36.966944	105.506389	7,900	16	87	44.7	Costilla Creek near Costilla, NM (1936 – 2002)
08261000	36.989167	105.531667	7,758	0	444	15.3	Costilla Creek near Garcia, CO (1965 – 2002)
08248000	36.982222	106.073056	8,040	18	231	118	Los Pinos River near Ortiz, CO (1915 – 2002)
08275000	36.375556	105.548611	7,140	1.1	20	5.11	Rio Fernando de Taos near Taos, NM (1963 – 1980)
08252000	37.000833	105.721944	7,390	78	858	345	Rio Grande at CO-NM State Line (1953 – 1982)
08275500	36.297777	105.581944	7,238	5.4	45	20.9	Rio Grande del Rancho near Talpa, NM (1952 – 2002)
08263500	36.734722	105.684722	7,110	121	1,238	461	Rio Grande near Cerro, NM (1948 – 2002)
08268200	36.535278	105601944	7,254	14	36	24.8	Rio Hondo at Damsi at Valdez, NM (1963 – 1966)
08267500	36.541667	105.555833	7,650	13	72	35.4	Rio Hondo near Valdez, NM (1934 – 2002)
08276000	36.388889	105.633333	6,709	14	197	59.0	Rio Pueblo de Taos at Los Cordovas, NM (1910 – 1965)
08276300	36.377500	105.668056	6,652	12	194	64.6	Rio Pueblo de Taos below Los Cordovas, NM (1957 – 2002)
08275300	36.393889	105.623056	6,747	7.7	110	29.3	Rio Pueblo de Taos near Ranchito, NM (1957 – 1980)
08269000	36.439444	105.503056	7,380	7.0	73	29.2	Rio Pueblo de Taos near Taos, NM (1913 – 2002)
08247500	36.993056	106.038056	7,970	2.4	62	25.2	San Antonio River at Ortiz, CO (1919 – 2002)

Notes:
Shading identifies gages that are not currently active.
cfs = Cubic feet per second
[a]Unweighted average for period of record.

Figure 2.4 USGS Average Daily Streamflow, Costilla Creek near Costilla, NM (2000)

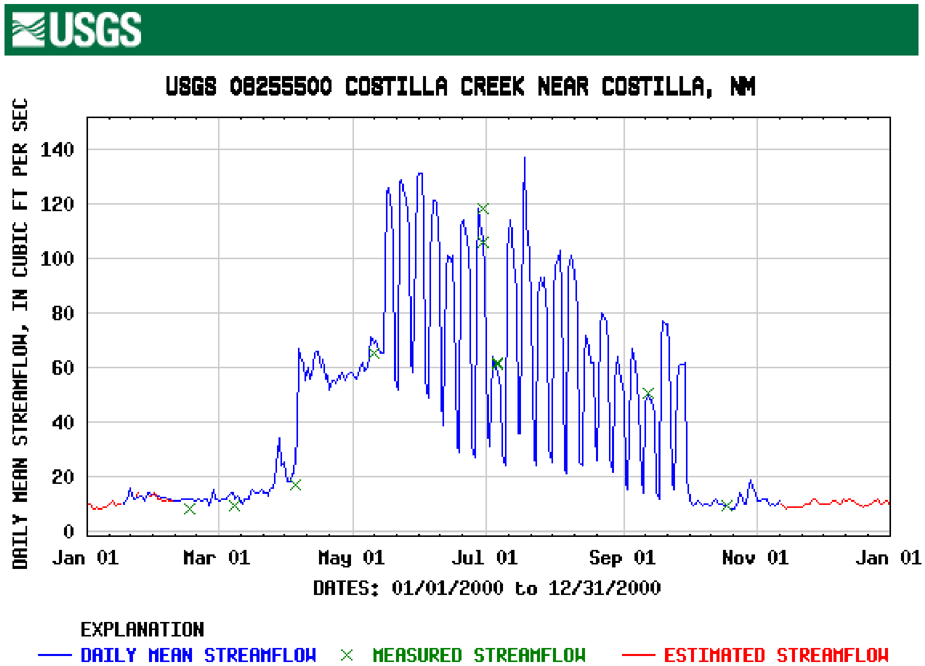


Figure 2.5 USGS Average Daily Streamflow, Costilla Creek near Garcia, CO (2000)

Figure 2.6 USGS Average Daily Streamflow, Los Pinos River near Ortiz, CO (2000)

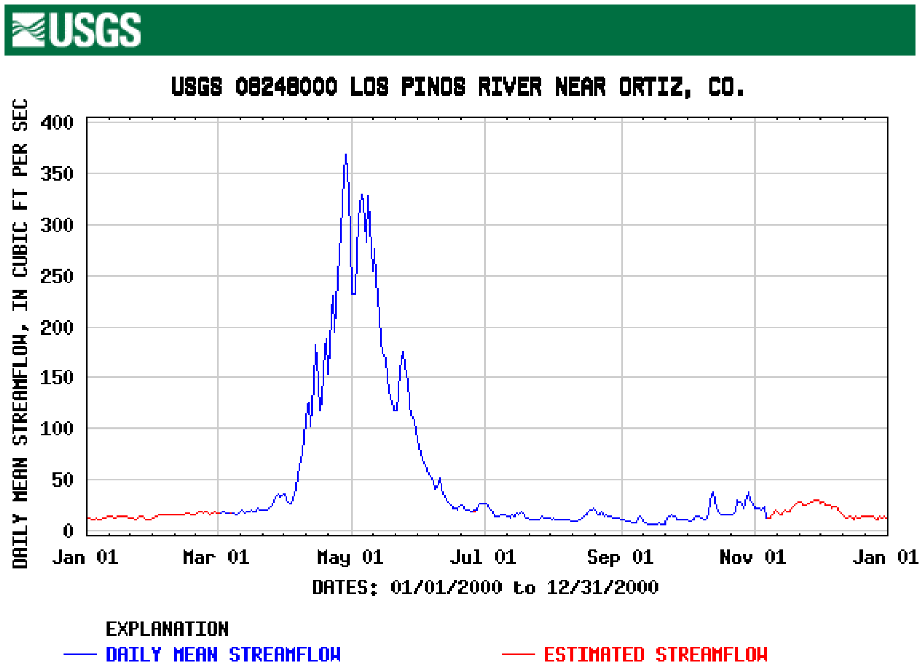


Figure 2.7 USGS Average Daily Streamflow, Rio Grande near Cerro, NM (2000)

Figure 2.8 USGS Average Daily Streamflow, Rio Hondo near Valdez, NM (2000)

Figure 2.9 USGS Average Daily Streamflow, Rio Pueblo de Taos below Los Cordovas, NM (2000)

Figure 2.10 USGS Average Daily Streamflow, Rio Pueblo de Taos near Taos, NM (2000)

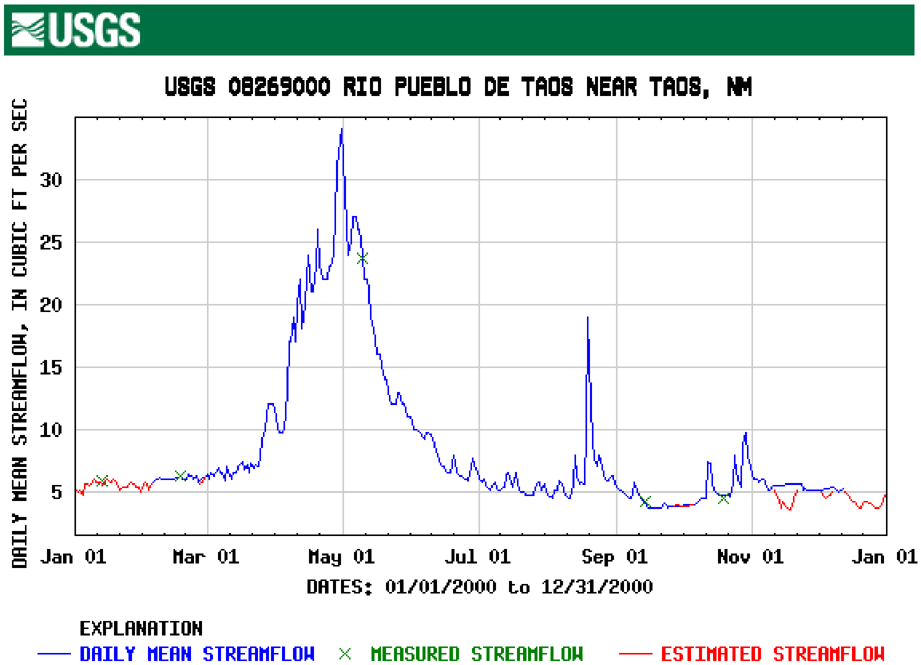


Figure 2.11 USGS Average Daily Streamflow, San Antonio River at Ortiz, CO (2000)